RENR2307-02
September 2002

Systems Operation Testing and Adjusting

C-15, C-16 and C-18 On-highway Engines

W1A1-Up (Engine)
CJP1-Up (Engine)
MDP1-Up (Engine)
MEP1-Up (Engine)
6NZ1-Up (Engine)
7CZ1-Up (Engine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that the product will not be damaged or be made unsafe by the operation, lubrication, maintenance or repair procedures that you choose.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Caterpillar dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

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Systems Operation Section

i01819103

Engine Design

SMCS Code: 1000

S/N: 6NZ1-Up

C-15

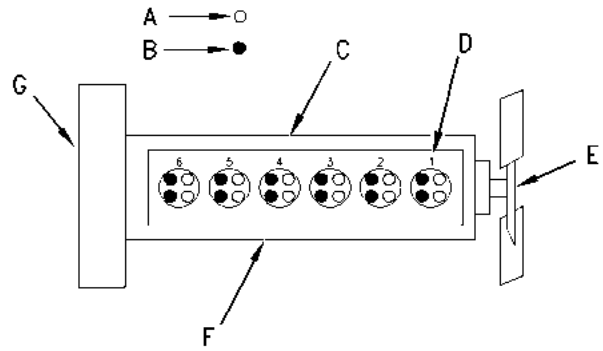

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Illustration 1

Cylinder and valve location

(A) Inlet valves
(B) Exhaust valves
(C) Left side of the engine
(D) Cylinder number
(E) Front of the engine
(F) Right side of the engine
(G) Flywheel

Bore ..... 137.0 mm (5.39 inch)

Stroke ..... 165.0 mm (6.50 inch)

Displacement ..... 14.6 L (890 in^3)

Cylinder arrangement ..... In-Line six cylinder

Valves per cylinder 4

The adjustment for the inlet valve lash is the following value. ..... 0.38 mm (0.015 inch)

The adjustment for the exhaust valve lash is the following value. ..... 0.76 mm (0.030 inch)

Firing order (Injection Sequence) 1, 5, 3, 6, 2, 4

Crankshaft rotation is viewed from the flywheel. Crankshaft rotation ..... counterclockwise

Note: The front end of the engine is opposite the flywheel end. The left side and the right side of the engine are viewed from the flywheel end. The No. 1 cylinder is the front cylinder.

i01811470

Engine Design

SMCS Code: 1000

S/N: W1A1-Up

S/N: 7CZ1-Up

C-16

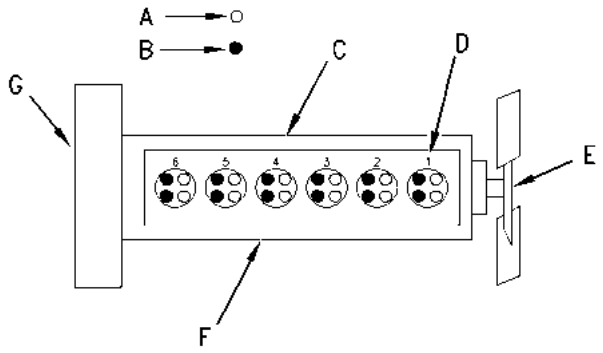

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Illustration 2

Cylinder and valve location

(A) Inlet valves
(B) Exhaust valves
(C) Left side of the engine
(D) Cylinder number
(E) Front of the engine
(F) Right side of the engine
(G) Flywheel

Bore ..... 140.0 mm (5.51 inch)

Stroke ..... 171.0 mm (6.73 inch)

Displacement ..... 15.8 L (964 in^3)

Cylinder arrangement ..... In-Line six cylinder

Valves per cylinder 4

The adjustment for the inlet valve lash is the following value. ..... 0.38 mm (0.015 inch)

The adjustment for the exhaust valve lash is the following value. ..... 0.76 mm (0.030 inch)

Firing order (Injection Sequence) 1, 5, 3, 6, 2, 4

Crankshaft rotation is viewed from the flywheel. Crankshaft rotation ..... counterclockwise

Note: The front end of the engine is opposite the flywheel end. The left side and the right side of the engine are viewed from the flywheel end. The No. 1 cylinder is the front cylinder.

i01811642

Engine Design

SMCS Code: 1000

S/N: CJP1-Up

S/N: MDP1-Up

S/N: MEP1-Up

C-18

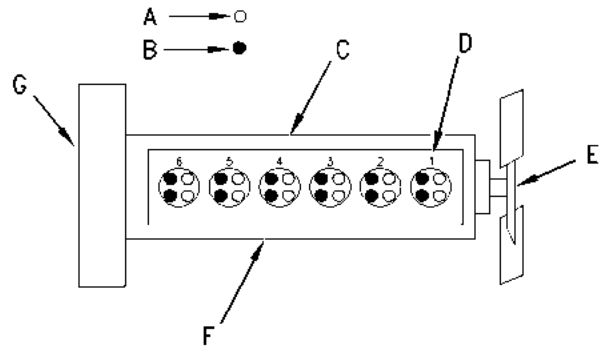

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Illustration 3

Cylinder and valve location

(A) Inlet valves
(B) Exhaust valves
(C) Left side of the engine
(D) Cylinder number
(E) Front of the engine
(F) Right side of the engine
(G) Flywheel

Bore ..... 145.0 mm (5.71 inch)

Stroke ..... 183.0 mm (7.20 inch)

Displacement ..... 18.0 L (1100 in^3)

Cylinder arrangement ..... In-Line six cylinder

Valves per cylinder 4

The adjustment for the inlet valve lash is the following value. ..... 0.38 mm (0.015 inch)

The adjustment for the exhaust valve lash is the following value. ..... 0.76 mm (0.030 inch)

Firing order (Injection Sequence) 1, 5, 3, 6, 2, 4

Crankshaft rotation is viewed from the flywheel.
Crankshaft rotation ..... counterclockwise

Note: The front end of the engine is opposite the flywheel end. The left side and the right side of the engine are viewed from the flywheel end. The No. 1 cylinder is the front cylinder.

i01815862

General Information

SMCS Code: 1000

These engines are in-line six cylinder engines. The engines have a firing order sequence of 1, 5, 3, 6, 2, 4. The rotation of these engines is counterclockwise when the engine is viewed from the flywheel end of the engine. These engines utilize a turbocharger and an air-to-air aftercooler.

The Electronic Unit Injector system (EUI) eliminates many of the mechanical components that are traditionally used in the fuel injector assembly. The EUI also provides increased control of the timing and increased control of the fuel air mixture. The timing advance is achieved by precise control of the fuel injection timing. Engine speed is controlled by adjusting the injection duration.

The engine has built-in diagnostics in order to ensure that all of the components are operating properly. In the event of a system component failure, the operator will be alerted to the condition by a check engine light. The check engine light is located on the dashboard. An electronic service tool can be used to read the numerical code of the faulty component or condition. Also, the cruise control switches can be used to flash the code on the check engine light. Intermittent faults are logged and stored in memory.

Starting The Engine

The engine's ECM will automatically provide the correct amount of fuel in order to start the engine. Do not hold the throttle down while the engine is cranking. If the engine fails to start in 30 seconds, release the starting switch. Allow the starting motor to cool for two minutes before the starting motor is used again.

NOTICE
Excessive ether (starting fluid) can cause piston and ring damage. Use ether for cold weather starting purposes only.

Cold Mode Operation

The ECM will set cold mode when the coolant temperature is below 18 °C (64 °F).

Cold mode is activated five seconds after the start of the engine. During cold mode, low idle speed will be increased to 800 rpm. After 60 seconds, the engine speed is reduced to 600 rpm. Engine power will be limited until cold mode is deactivated.

Cold mode will be deactivated when the coolant temperature reaches 18 °C (64 °F).

Cold mode varies the amount of fuel that is injected for white smoke cleanup. Cold mode also varies the timing for white smoke cleanup. The engine operating temperature is usually reached before the walk-around inspection is completed.

After cold mode is completed, the engine should be operated at low speed until normal operating temperature is reached. The engine will reach normal operating temperature faster when the engine is operated at low speed and low power demand.

i01816763

Glossary of Electronic Control Terms

SMCS Code: 1900

Accelerator Pedal Position – The accelerator pedal position is the interpretation from the ECM of the signal from the Accelerator Pedal Position Sensor.

Accelerator Pedal Position Sensor – This is an electronic sensor that is connected to the accelerator pedal. The sensor sends a Pulse Width Modulated Signal to the ECM. The ECM will then vary the duty cycle according to the pedal position.

ATA Data Link – The data link is an electrical connection for communication with other devices that are based on the microprocessor. These devices are compatible with the ATA (American Trucking Association) and with SAE Standards, “Section J1587 and Section J1708”. These devices include trip recorders, electronic dashboards and maintenance systems. The data link is also the medium for communication that is used for programming and troubleshooting with the Caterpillar electronic service tool.

Aftermarket Device – The customer or the machine (OEM) installs these devices or accessories. This installation is completed after the engine is delivered.

Air-to-Air Aftercooler (ATAAC) – This device cools the intake air after the air is compressed by the turbocharger. The intake air is then passed through an aftercooler (heat exchanger) before going to the intake manifold. The aftercooler is mounted in the front of the radiator.

Alternating Current (AC) – The direction of current flow changes. The current flow alternates constantly.

American Wire Gauge (AWG) – This is the measurement of the diameter of electrical wire. This is also the measurement of the ability of electrical wire to carry current. A smaller AWG number reflects a larger wire.

Atmospheric Pressure Sensor – This sensor measures atmospheric air pressure in the crankcase. The sensor sends the signal to the electronic control module (ECM).

Before Top Center (BTC) – The 180 degrees of crankshaft rotation before the piston reaches the top center position in the normal direction of rotation.

Boost Pressure Sensor – This sensor measures inlet manifold air pressure. The sensor sends the signal to the ECM.

Brake Pedal Position Switch – This switch is supplied and installed by the OEM. The switch is typically a pressure switch. The switch is normally closed when the pedal is released. Depressing the brake will open the circuit.

Bypass Circuit – This circuit substitutes an existing circuit. The circuit is usually a temporary circuit. The circuit is used for testing.

Calibration – Calibration is an electronic adjustment of a sensor signal.

Camshaft Position Sensor – This sensor provides a Pulse Width Modulated signal to the ECM. The ECM interprets this signal as the camshaft position in order to determine the top center position of cylinder number 1.

Caterpillar Engine Monitoring – The part of the Caterpillar Electronic Engine Control that monitors Coolant Temperature, Oil Pressure, Intake Manifold Air Temperature and Coolant Level. This will alert the operator of detected problems. The Coolant Temperature, Intake Manifold Air Temperature, and Oil Pressure Sensors are supplied by Caterpillar and monitored by the ECM. The Coolant Level Sensor is installed by the OEM and monitored by the ECM. An aftermarket Engine Monitoring System does not interface with the Caterpillar Electronic Engine Control.

Check Engine Lamp – This is used to warn the operator of the presence of an active diagnostic code. This is also called the Diagnostic Lamp.

Clutch Pedal Position Switch – This switch is supplied and installed by the OEM. The switch is an adjustable limit switch that is mounted near the pedal. The switch is normally closed when the pedal is released. Depressing the clutch will open the circuit.

Coolant Level Sensor – This sensor detects the absence or presence of coolant at the probe. The sensor sends the signal to the ECM. This sensor is installed by the OEM.

Cooling Fan Relay – This relay is supplied and installed by the OEM. The relay is controlled by the ECM.

Coolant Temperature Sensor – This sensor detects the engine coolant temperature for Cold Mode operation and Caterpillar Engine Monitoring. If Engine Monitoring has been programmed to be OFF the sensor will not detect the engine coolant temperature.

Crankshaft Position Sensor – This sensor provides a Pulse Width Modulated signal to the ECM. The ECM interprets this signal as the crankshaft position in order to determine the top center position of cylinder number 1.

Cruise Control Range – The cruise control operates within this range. The cruise control range is usually limited to the speed range that is anticipated for the application.

Custom Data – This allows the owner to specify the operating parameters of the engine application while the engine is in service. This data is for monitoring purposes. Custom Data is a part of the ECM fleet trip data.

Customer Specified Parameter – The customer can set this parameter value. The parameter value may be protected by Customer Passwords.

Data Link – The data link is an electrical connection for communication with other onboard microprocessor based devices that use the data link. These devices are compatible with SAE Standards. These devices include trip recorders, electronic dashboards and maintenance systems. The data link is also the medium for communication that is used for programming and troubleshooting with the Caterpillar electronic service tool.

Desired rpm – The desired engine speed (rpm) is input to the electronic governor within the ECM. The following criteria are used in order to determine the desired engine speed (rpm): the Accelerator Pedal Position Sensor, the Crankshaft Position Sensor, and the Customer Parameters.

Desired Timing Advance – The fuel injection timing advance is calculated by the ECM. The calculation is used to meet emission and performance specifications.

Diagnostic Code – A diagnostic code is an indication of a problem or event in the electronic system.

Diagnostic Event Code – These codes indicate an event. The codes are not necessarily an indication of a problem within the electronic system.

Diagnostic Fault Code – These codes indicate an electronic system malfunction which will indicate a problem with the electronic system.

Diagnostic Flash Code – This code indicates a malfunction of the electronic system. This code can also indicate an event that is detected by the electronic system. The code is indicated on the Check Engine/Diagnostic Lamp.

Diagnostic Lamp – This is used to warn the operator of the presence of an active diagnostic code. Another name for this lamp is the Check Engine Lamp.

Direct Current (DC) – Direct current is the type of current that flows consistently in only one direction.

Duty Cycle – See Pulse Width Modulation.

Electronic Engine Control – The electronic engine control is a complete electronic system. The electronic engine control monitors the engine operation under all conditions. The electronic engine control also controls the engine operation under all conditions.

Electronic Technician (ET) – Electronic Technician is a Caterpillar electronic service tool. ET is used for diagnostics and for programming a variety of electronic controls.

Electronic Unit Injector (EUI) – The injection pump is a mechanically actuated, electronically controlled unit injector. The EUI combines the pumping, electronic fuel metering, and injecting elements into a single unit.

Engine Control Module (ECM) – The ECM is the engine's control computer. The ECM provides power to the electronics for the system. The ECM monitors the information that is input by the system. The ECM acts as a governor in order to control engine rpm.

Engine Control Module (ECM) Fan Control – The ECM may control the cooling fan through a relay that is installed by the OEM. The ECM controls the relay that is based on coolant temperature, inlet manifold air temperature, and boost pressure. The relay can also be controlled by the ECM when the following switches are installed by the OEM:air conditioning high pressure switch, PTO ON/OFF, manual fan override switch, and retarder solenoid

Engine Retarder Solenoids – The Engine Retarder is installed by Caterpillar. The solenoids are driven directly from the ECM.

Estimated Dynamic Timing – This is the estimated calculation of actual injection timing by the ECM.

Failure Mode Identifier (FMI) – This identifies the type of failure that was experienced by the component. This was adopted from SAE Standards, "Section J1587" diagnostics.

Flash Code (FC) – A flash code is a Caterpillar proprietary code number which is flashed on the diagnostic lamp.

Fuel Ratio Control (FRC) – The FRC is a limit that is based on the control of the fuel to the air ratio. The FRC is used for emission control. When the ECM senses a higher turbocharger outlet pressure, the ECM increases the limit for the FRC in order to allow more fuel into the cylinders.

Fuel Position – The fuel position is a signal within the ECM. The signal is from the electronic governor. The signal goes to the fuel injection control. The signal is based on the desired engine speed, the FRC, the rated position and engine speed.

Fuel Temperature Sensor – This sensor detects the fuel temperature. The ECM monitors the fuel temperature. The ECM adjusts the calculated fuel rate accordingly.

Full Load Setting (FLS) – This is the fuel system adjustment that is made at the factory. The adjustment is used to fine tune the fuel system. The correct value for this parameter is stamped on the 9L-6531 Information Plate. This parameter must be programmed. If the parameter is not programmed, a Diagnostic Code 253-02 Check Customer or a System Parameters Fault Code 56 will be generated.

Full Torque Setting (FTS) – This is similar to Full Load Setting. The parameter for full torque setting must be programmed or a Diagnostic Code 253-02 Check Customer or a System Parameters Fault Code 56 will be generated.

Gear Down Protection – This is a Programmable High Gear Limit. This is used to promote driving in higher gears for increased fuel economy.

Harness – The harness is the bundle of wiring that connects all the components of the EUI system.

Hertz (Hz) – Hertz is the measure of frequency in cycles per second.

Histogram – The histogram is a bar graph. This bar graph indicates the relative frequency of engine operation within specific operating ranges.

Inlet Air Temperature Sensor – This sensor detects the inlet air temperature. The ECM monitors the inlet air temperature and the coolant temperature. The inlet air temperature sensor is a part of Caterpillar Engine Monitoring.

Integrated Electronic Controls – The engine is designed with the electronic controls as a necessary part of the system. The engine will not operate without the electronic controls.

Oil Pressure Sensor – This sensor measures engine oil pressure. The sensor sends a signal to the ECM as part of the Caterpillar Engine Monitoring.

Open Circuit – An open circuit is a broken electrical connection. The signal or the supply voltage cannot reach the intended destination.

Original Equipment Manufacturer (OEM) – An OEM is an equipment manufacturer that uses Caterpillar engines to power vehicles that are produced.

Parameter – A parameter is a programmable value which affects the characteristics or the behavior of the engine and/or machine.

Parameter Identifier (PID) – This is the two or three digit code which is assigned to each component.

Passive Magnetic Speed Sensor – This speed sensor does not require a power connection and a ground connection. This speed sensor produces a signal that is based on the change in the magnetic flux of a ferrous metal gear that is near the sensing tip.

Password – A password is a group of numeric characters or alphanumeric characters. A password is designed to restrict the changing of information in the ECM. The EUI system requires correct factory passwords in order to clear certain logged events. Factory passwords are also required in order to change the engine rating.

Personality Module Or Ratings Personality Module – A personality module refers to the software that is downloaded into the ECM. The module contains all the instructions (software) for the ECM and performance maps for a specific horsepower family.

Power Take-Off (PTO) – This requires a dedicated PTO switch with ON/OFF positions. This mode permits setting an engine rpm with the following functions: cruise Set/Resume Switch, remote PTO Set/Resume Switch, remote accelerator, cab accelerator, and programmable values.

Pro-Link – The Pro-Link is a hand-held service tool that is electronic. The Pro-Link is manufactured by Micro Processor Systems, Inc. (MPSI). This is available with a Caterpillar cartridge in order to service Caterpillar electronic engines.

Pulse Width Modulation (PWM) – A PWM is a digital type of an electronic signal that corresponds to a measured variable. The length of the pulse (signal) is controlled by the measured variable. The variable is quantified by a certain ratio. This ratio is the percent of "TIME-ON" that is divided by the percent of "TIME-OFF". The PWM is also known as the Duty Cycle.

Rated Fuel Position – The rated fuel position indicates the maximum allowable fuel position. The rated fuel position will produce rated power for this engine configuration.

Reference Voltage – The reference voltage is a regulated voltage that is used by the sensor in order to generate a signal voltage.

Sensor – A sensor is used to detect a change in the pressure, in the temperature, or in mechanical movement. When any of these changes are detected, a sensor converts the change into an electrical signal.

Short Circuit – A short circuit is an electrical circuit that is mistakenly connected to an undesirable point. For example, an electrical contact is made with the frame whenever an exposed wire rubs against a vehicle's frame.

Signal – A signal is a voltage or a wave that is used to transmit information that is typically from a sensor to the ECM.

Speed Burp – A speed burp is a sudden brief change in engine speed.

Speed Circuit – This is the circuit that includes the speed sensor, the harness and the ECM.

Speed Sensor – The speed sensor is an electromagnetic pickup that measures speed from the rotation of gear teeth in the drive train.

Standard SAE Diagnostic Communications Data Link – Refer to the ATA Data Link.

Subsystem – A subsystem is part of the EUI system that relates to a particular function.

Supply Voltage – Supply voltage is a constant voltage that is supplied to a component in order to provide electrical power for operation. Supply voltage may be generated by the ECM. The supply voltage may also be the battery voltage that is supplied by the vehicle wiring.

"T" Harness – This harness is a test harness that is designed to permit normal circuit operation and the measurement of the voltage simultaneously. Typically, the harness is inserted between the two ends of a connector.

Total Tattletale – The total tattletale is the total number of changes to all system parameters.

Transducer – A transducer is a device which converts a mechanical signal to an electrical signal.

Trip Recorder – This device records the operating parameters of the vehicle and the engine while the vehicle is in service. The data from the trip recorder is used to analyze operating habits. The data from the trip recorder is used to develop operating logs.

Vehicle Speed Circuit – This circuit includes the vehicle speed sensor, the harness and the ECM.

Vehicle Speed Sensor – This is an electromagnetic pickup that measures vehicle speed from the rotation of gear teeth in the drive train of the vehicle.

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Electronic Control System Components

SMCS Code: 1900

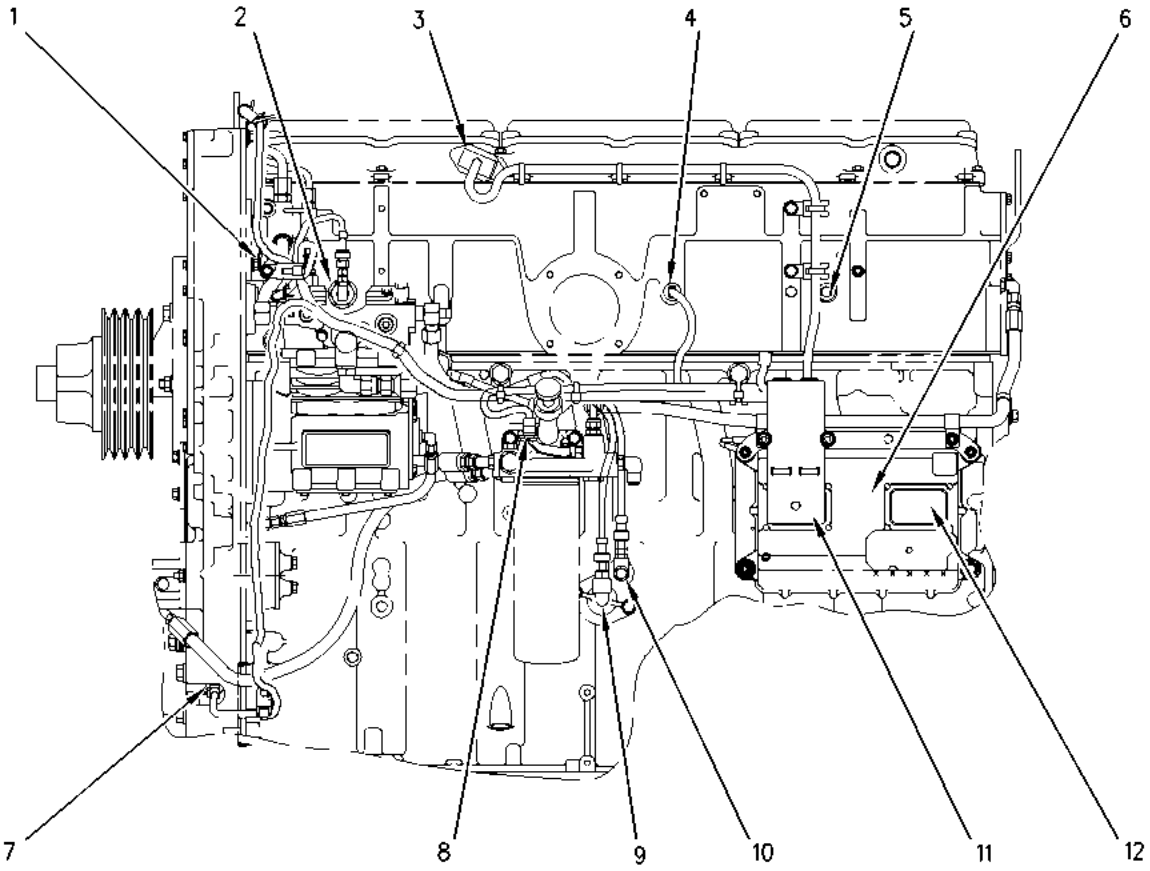

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Illustration 4

Typical example

(1) Camshaft position sensor
(2) Boost pressure sensor
(3) Connector for the electronic unit injector P300/J300
(4) Inlet air temperature sensor
(5) Ground point for the OEM
(6) Engine Control Module (ECM)
(7) Crankshaft position sensor
(8) Fuel temperature sensor
(9) Atmospheric pressure sensor
(10) Engine oil pressure sensor
(11) ECM connector that is for the engine
(12) ECM connector that is for the OEM